from 4.31 p. m. to 5.04 p. m. Hail, size and shape of a pea, fell for thirty seconds previous to the rain. The highest wind, lasting five minutes, was twenty-four miles per hour. Direction of wind before storm, northeast; after, southeast. Temperature before storm, 85°; after, 71°. During the storm the low clouds had a whirling motion, branches were broken and grain was prostrated. On July 20th, at 4.48 a. m., one of the most violent thunder-storms, consisting of rapid lightning flashes and peal on peal of thunder, broke on the station. It lasted three hours, and was most severe from 5.40 to 6.15. Rain (1.00 inch) began at 4.19, falling in torrents till 8.15, and ending at 9.15 a. m. No hail; light wind, east and south; temperature before, 64°.5; after, 68°.

### CHART OF ELECTROMETER READINGS.

[By Prof. T. C. MENDENHALL, Assistant.]

The first diagram of chart vi shows the results of a set of observations made on the top of the Washington Monument. The elevation of the collector is about five hundred and five feet above the ground. The observations were taken every five minutes, except between 11.30 a. m. and 12 m., and between 1.30 and 2 p. m., when the interval was one minute. The day was cloudless but hazy, the wind from the southwest and light. During the forenoon the needle oscillated almost continually, indicating variable, high, positive potentials. During the afternoon the indications were much less in value, and more regular in character, the weather remaining, however, apparently the same. About 12.30 p. m. there was a period of about eight minutes during which the needle was again very active, after which the indications became again of less value and less variable.

The second diagram of chart vi represents the values obtained at the Sloane Laboratory, Yale College, during the passage of a thunder-storm, July 14, 1886. Thunder was first heard at 6.45 p. m.; loudest from 7 to 7.05 p. m., and last heard at 7.15 p. m. The wind, before the storm, was from the east, velocity about twelve miles an hour; during the storm from the east and southeast, and after the storm from the east. Rain began at 6.54 p. m. and ended at 8.30 p. m. Lightning was recorded at 7.02 and 7.07 p. m.

The following notes are abstracted from the report of the observer at that station:

Negative potentials occurred on the following dates: June 23d, heavy rain and east wind. June 30th, at 1 p. m., very slight indications, weather clear, wind south. July 3d, 11 a. m., very slight indications, weather clear, wind northwest. July 9th, 9 a. m., wind northeast, light rain; 3 p. m., wind south, light rain. July 12th, 1 p. m., slight indications, weather clear, wind south. July 16th, throughout the day large values, continued rain. July 21st, at 11 a. m., light rain, southeast wind. July 27th, at 11 a. m., large values, heavy rain. All days on which rain fell were characterized by negative potentials. A faint auroral display observed at 2 a. m., June 30th; was preceded, during the afternoon of the 29th, by negative potential.

At Boston, Massachusetts, on July 27th, the electrometer gave evidence of unusual disturbance, and special readings were made at intervals of two minutes from 9 a. m. until 11 a. m.

The following abbreviated table is from the observer's record:

| Time. | Volts. | Remarks. | Time. | Volts. | Remarks. |
|---|---|---|---|---|---|
| *A. M.* | | | *P. M.* | | |
| 9.00 | — 10 | Threatening. | 2.00 | + 25 | Light rain. |
| 9.02 | — 8 | | 2.06 | +150 | |
| 9.04 | 0 | | 2.08 | + 60 | Heavy rain. |
| 9.08 | + 8 | Light showers. | 2.10 | +400 | |
| 9.10 | + 14 | | 2.12 | — 95 | |
| 9.12 | — 40 | Rain ended. | 2.14 | +360 | |
| 9.20 | — 12 | | 2.16 | —180 | Light rain. |
| 9.30 | 0 | | 2.18 | — 60 | |
| 9.38 | + 20 | | 2.20 | — 5 | |
| 9.40 | 0 | | 2.22 | + 40 | Heavy rain. |
| 9.46 | + 40 | | 2.24 | + 65 | |
| 9.50 | — 16 | | 2.26 | + 25 | |
| 10.00 | — 20 | | 2.28 | + 48 | |
| 10.10 | — 5 | | 2.30 | + 22 | Light rain. |
| 10.18 | + 20 | Light rain began. | | | |
| 10.28 | — 20 | | | | |
| 10.30 | + 15 | | | | |
| 10.40 | + 5 | | | | |

There was a very brilliant aurora during the night of July 27th. At 6.40 a. m. July 28th the potential exceeded 1,100 volts. From 7 a. m. until 8.15 a. m. the mean potential of the air exceeded 1,000 volts. At 9 a. m. it averaged about 265. It continued falling steadily. At 11 a. m. it was zero, and at 1 p. m., minus ten, where it remained during the rest of the day.

The third diagram of chart vi represents the potential variations during a thunder-storm at Cornell University, Ithaca, New York. The observations, in detail, are given below:

During the month negative readings occurred on the following dates: July 7th, at 9 a. m., in value about 16 volts, the weather hazy, the wind northwest and fresh; low positive potentials during the rest of the day, the weather remaining cloudy and threatening. July 14th, at 11 a. m., mean value 220 volts, weather cloudy, and at times raining. At 1 p. m., 1,425 volts, and a minute later 670 volts, changing to positive 400 at 1.02 p. m., 500 at 1.03, and zero at 1.04 p. m. July 17th, during the forenoon, slight negative values, becoming greater; weather clear and warm, with light haze. July 18th, at noon, during thunder-storm; 3 p. m., 3,250 volts during thunder-storm. July 20th, at 11 a. m., slightly negative for a few moments. July 28th, at 9 a. m., weather clear, calm, and hazy. Rain occurred on July 14th, during the night of the 15th, on the 17th, 18th, 21st, 25th, and 26th.

During the thunder-storm of July 14th the following observations were made:

| Time. | Volts. | Remarks. | Time. | Volts. | Remarks. |
|---|---|---|---|---|---|
| *A. M.* | | | *A. M.* | | |
| 10.57 | + 850 | Rain commenced. | 11.37 | + 125 | |
| 11.03 | — 300 | Rain increasing. | 11.38 | + 225 | |
| 11.13 | + 350 | | 11.40 | + 300 | |
| 11.17 | 0 | Rain diminishing. | 11.42 | + 120 | |
| 11.18 | — 125 | | 11.44 | — 80 | |
| 11.19 | — 125 | | 11.46 | — 170 | |
| 11.20 | + 50 | Rain increasing. | 11.48 | — 85 | |
| 11.21 | + 375 | | 11.50 | — 150 | Rain increasing. |
| 11.22 | +1300 | Very heavy rain. | 11.51 | — 300 | |
| 11.23 | +1550 | | 11.52 | 0 | |
| 11.25 | +1400 | Rain diminishing. | 11.53 | + 270 | |
| 11.26 | +1300 | | 11.54 | + 125 | |
| 11.28 | +1600 | | 11.55 | — 150 | |
| 11.30 | +1000 | Rain diminishing. | 11.56 | — 200 | |
| 11.31 | + 700 | | 11.58 | — 175 | |
| 11.32 | + 250 | | 12.00 m. | — 180 | |
| 11.33 | + 25 | | 1.00 p. m | —1425 | High southeast wind, light rain. |
| 11.34 | — 50 | Light rain. | | | |
| 11.35 | — 25 | | 1.05 p. m | + 10 | |
| 11.36 | + 25 | | 3.00 p. m | + 45 | |

## OPTICAL PHENOMENA.

### SOLAR HALOS.

Solar halos were observed in the various states and territories during the month, as follows:

*Alabama.*—Mobile, 10th.

*Arizona.*—Yuma, 12th, 20th.

*Connecticut.*—New Haven, 2d; New London, 29th.

*Dakota.*—Webster, 30th.

*Florida.*—Sanford, 1st, 5th; Key West, 1st, 8th, 9th.

*Georgia.*—Augusta, 2d; Savannah, 11th.

*Illinois.*—Pekin, 1st to 5th, 7th, 8th, 10th, 12th, 20th, 24th, 25th, 27th.

*Indiana.*—Jeffersonville, 13th, 16th.

*Iowa.*—Keokuk, 23d.

*Kansas.*—Wyandotte, 20th, 21st, 22d; Salina, 27th; Yates Centre, 30th.

*Maine.*—Cornish, 9th, 14th, 21st; Portland, 9th, 21st; Gardiner, 21st.

*Massachusetts.*—Milton, 5th, 18th, 25th; Heath, 19th; Provincetown, 25th, 26th, 28th, 29th, 30th.

*Michigan.*—Escanaba, 8th; Marquette, 8th, 29th; Grand Haven, 11th.

*New Hampshire.*—Mount Washington, 25th.

*New Jersey.*—Clayton, 1st, 15th; Beverly, 13th.

*New York.*—Mountainville, 1st; Setauket, 1st, 2d; Palermo, 2d.

*North Carolina.*—New River Inlet, 9th, 15th, 18th, 25th.

*Ohio.*—Wauseon, 2d, 25th, 29th.

*Oregon.*—Roseburg, 4th, 26th; East Portland, 6th.